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EVALUATION OF MAINTAINABILITY ENHANCEMENT
FOR TCP/TSP REVISION 6.0 UPDATE .20

Norman F. Schneidewind

February 1982

Final Report: 1 Jan 80 to 1 Jan 82

Approved for public release; distribution unlimited

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| Software standards | MIL-STD 1679 |
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A system of documentation which was designed to aid programmers of the Command and Control System Maintenance Agency (CCSMA) in maintaining the Trident Command and Control System software was evaluated. This system is called "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20" or simply 6.0/.20. It is essentially a hierarchical method of charting software procedures and the relationship between procedures. The difficulty of trying to overlay a structured documentation technique on programs which are inherently non-structured (written in low-level language and patched) is

discussed. Discrepancies which arose between the newly constructed charts and the original listings are highlighted. A conclusion of this study is that rather than improving clarity, applying structured documentation to non-structured programs may result in the opposite effect--incomplete, inconsistent, and ambiguous documentation--because a hierarchical format cannot adequately represent a non-hierarchical program.

SECNAVINST 3560.1 and MIL-STD 1679 (Navy) are considered by CCSMA to be relevant documents for maintenance purposes. Therefore, the documentation system was checked for conformance with applicable sections of 3560.1 and 1679. In addition, the documentation system was compared with applicable sections of FIPS PUB 38, published by the National Bureau of Standards. Although officially FIPS PUB 38 applies to ADP and not to embedded computer systems, it provides good guidelines for program documentation and maintenance. It was found that 6.0/.20 does not include coverage of many of the applicable sections of the three documents.

SUMMARY

Trident CCSMA requested the Naval Postgraduate School to evaluate the "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20," referred to as 6.0/.20. The approach for accomplishing this task was to compare 6.0/.20 for compliance or conformity with applicable sections of SECNAVINST 3560.1, FIPS PUB 38, AND MIL-STD 1679. In addition, a sample of 6.0/.20, Volume 2, was examined in some detail for its usefulness as a software maintenance tool in terms of consistency, completeness, understandability, and absence of errors. Many suggestions for improvement have been made.

Our conclusions are that 6.0/.20:

- Does enhance maintainability. However, we believe listings alone, even if they are structured, are inadequate for maintenance purposes.
- Does not include coverage of significant applicable items called for in 3560.1, FIPS PUB 38, and 1679.
- Appears to be incomplete and to contain a moderate amount of inconsistencies, ambiguities, and errors.
- Could provide an excellent software maintenance tool if its quality were improved in accordance with the suggestions made in this report.

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# I. INTRODUCTION

## A. Purpose

Trident CCSMA has requested the Naval Postgraduate School (NPS) to evaluate the "Maintainability Enhancement for TCP/TSP Revision 6.0 Update .20" documents, subsequently referred to as 6.0/.20, with respect to its usability for maintaining Trident Command and Control System software.

## B. Approach

It is understood that one of the governing documents for the production and use of Trident software is "Department of the Navy Tactical Digital Systems Documentation Standards," SECNAVINST 3560.1, 8 August 1974. Therefore, it was deemed appropriate to use this standard as one means of evaluating the subject documents. It was felt that, as a minimum, documentation used on the Trident project should meet the applicable sections of this standard. However, recognizing that this standard was issued many years ago and that the field of software engineering has evolved in the interim, additional criteria which reflect more modern software design and maintenance techniques were used in the evaluation.

The part of 3560.1 which appears to be most applicable to maintenance is the Program Description Document, pages 2-137 to 2-152. As stated in this document, its purpose, in part, is the following: "As a detailed compendium of the subprogram structure, the Program Description document

will serve as the essential instrument for subsequent use by operational, maintenance, and contractor personnel diagnosing troubles, making adaption changes, designing and implementing modifications to the system, and introducing or adding new subprogram functions to the completed program" (underlining added by the author).

Another means of evaluation was with respect to the publication "Guidelines for Documentation of Computer Programs and Automated Data Systems," National Bureau of Standards, Federal Information Processing Standards Publication 38 (FIPS PUB 38), February 15, 1976. As stated in FIPS PUB 38, its purpose is the following: "These guidelines provide a basis for determining the content and extent of documentation for computer programs and automated data systems. Software development phases and related document types are identified, several examples of documentation options are given, and content guidelines for ten document types are provided." Although, officially, this guideline is not applicable to Trident software because it was written to apply to ADP systems under the provisions of Public Law 89-306 (Brooks Bill), which excluded embedded computer systems, it is of technical interest because it is one of the few Federal Government software guidelines which covers program maintenance.

As stated in FIPS PUB 38, "The purpose of the Program Maintenance Manual is to provide the maintenance programmer with the information necessary to understand the programs, their operating environment, and their maintenance procedures." The Program Maintenance Manual is described on pages 45-47 of FIPS PUB 38.

It was also considered important to examine 6.0/.20 with respect to the applicable sections of MIL-STD 1679 (Navy), 1 December 1978,

the Navy's Military Standard for Weapon System Software Development. The applicable section of 1679 is primarily 5.11 Configuration Management, pages 23-24.

C. Scope

In order to ensure good software maintainability, it is necessary to use sound programming methodology and procedures, as well as provide good documentation. It is difficult to evaluate the quality of documentation and not also consider the quality of the product that has been documented, because good documentation of non-structured programs which contain machine language code, although of some benefit, will not result in good software maintainability, nor will good documentation of highly patched programs allow software to be easily maintained. In other words, if programs are inherently difficult to change and understand and may not have been designed with maintainability in mind, documentation may only make a marginal contribution to the improvement of maintainability. Thus, this project poses a dilemma because we have been asked to review and evaluate documentation for programs which are non-structured, contain significant amounts of machine language code, and are highly patched. It is understandable that this is the case, since the programs were designed prior to the availability of a mature structured programming methodology and high level languages for tactical system software development. In addition, although machine language patching is generally considered to be undesirable, for certain administrative and contractual reasons it is a prevalent practice in Navy embedded computer software development. The argument can be made that, because of these practices, good documentation is

even more important in this environment than it would be in those situations where the use of structured programming and high level languages provide a degree of self-documentation. Accordingly, the scope of this paper will be limited to evaluating the adequacy of 6.0/.20 for maintaining the TCP/TSP software, ignoring what is perhaps the more fundamental maintenance issue of the adequacy of the underlying software.

A major assumption of this study which affects its scope is that the 6.0/.20 documentation is to be evaluated independently of the program listings. It is noted that listings are not included in the version of 6.0/.20 dated 29 September 1979, although these were included in a prior version (undated). Quoting from Volume 1 of the version dated 29 September 1979, "The primary goal is to improve this software's maintainability by making the programs and their patches understandable and visible in a single simplified form," (underlining added by the author). The implication which has been derived based on the above statement and the fact that the listings are not included in the latest version, is that 6.0/.20 is to be used for maintenance purposes primarily on a stand-alone basis with listings utilized as a secondary source of information. This interpretation is critical with respect to some of the results obtained in this study, because certain deficiencies in 6.0/.20, which are noted later in this report, regarding such items as data design, tables and indexes, are not addressed by 6.0/.20 but are covered in the listings. If it was the intent to use the listings with 6.0/.20 in a coordinated fashion, it would be helpful to provide a detailed cross-referencing between the two. A method for accomplishing this cross-referencing is suggested

in a later section. The scope of this report is limited to considering 6.0/.20 as an independent tool for maintenance which does not rely extensively on the use of program listings. However, since the flowcharts are based on the program logic, as expressed in the listings, it was necessary to make extensive reference to the listings in this report in order to understand and evaluate 6.0/.20. In fact, a result of this analysis was the conclusion that the two mediums should be used as an integrated documentation package and not in isolation.

## II. EVALUATION OF 6.0/.20

A. With Respect to SECNAVINST 3560.1, Program Description Document, Pages 2-137 to 2-152.

The following 3560.1 pages and sections are covered by 6.0/.20:

| Page | Section | Title |
|---|---|---|
| 2-141 | 1. | Scope |
| 2-141 | 2. | Applicable Documents |
| 2-142 | 3. | Requirements |
| 2-142 | 3.1 | Subprogram Detailed Description |
| 2-143 | 3.2 | Subprogram Flow Diagrams |
| 2-148 | 3.6 | Conditions for Initiation |
| 2-149 | 3.8 | Interface Description |

The 3560.1 pages and sections which apparently are not covered by 6.0/.20 are identified below. It is possible that these sections are not applicable to certain volumes of 6.0/.20. However, the named missing sections were not found in any of the 6.0/.20 volumes for which copies were provided to NPS, so it is assumed that it was not intended to include these sections in 6.0/.20. A brief description of the intended contents of the missing sections as specified by 3560.1 is given:

| Page | Section | Title | Contents |
|---|---|---|---|
| 2-144 | 3.3 | Subprogram Data Design | General summary description of the subprogram data base. |
| 2-144 | 3.3.1 | Tables | Detailed description of each table used in the subprogram data base:<br>a. Table name.<br>b. Purpose and type.<br>c. Size and indexing procedure.<br>d. Structure and bit layout. |

| | | | |
|---|---|---|---|
| 2-145 | 3.3.2 | Variables | Detailed description of each variable used in the subprogram data base:<br>a. Variable name.<br>b. Purpose.<br>c. Structure and bit layout. |
| 2-145 | 3.3.3 | Flags | Detailed description of each flag used in the subprogram data base:<br>a. Flag name.<br>b. Purpose and status.<br>c. Structure and bit layout. |
| 2-145 | 3.3.4 | Indexes | Technical description of each index used in the subprogram data base:<br>a. Index name.<br>b. Purpose. |
| 2-146 | 3.3.5 | Common Data Base Reference | Complete list of all references to local and common data base items and the location of each reference. |
| 2-146 | 3.4 | Input/Output Formats | Brief description and graphic (sample) representation of each input and output message, card format, tape format, etc. processed by the subprogram. |
| 2-148 | 3.7 | Subprogram Limitations | Summary of any known or anticipated limitations of the subprogram. |
| 2-149 | 4. | Quality Assurance Provisions | Reference to all applicable test plans and procedures that have been used for verification of the subprogram. (6.0/.20 should reference the Trident Test Specification Requirements and Test Procedures which are described in Refs. 1 and 2.) |

NOTE: It was not possible to determine whether Section 3.5 Required System Library Subroutines was covered by 6.0/.20 because it was not known whether library subroutines were used.

B. With Respect to FIPS PUB 38, Program Maintenance Manual , Pages 45-47

The following Program Maintenance Manual sections are covered by 6.0/.20

| Section | Title |
|---|---|
| 1. | General Information |
| 1.1 | Summary |
| 1.2 | Environment |
| 1.3 | References |
| 2. | Program Descriptions |
| 2.1 | Program Identification |
| 2.1.1 | Problem and Solution Method |
| 2.1.2 | Input (description of) |
| 2.1.3 | Processing (logic, linkages, error handling) |
| 2.1.4 | Output (description of) |
| 2.1.5 | Interfaces |
| 2.1.7 | Run Description |
| 3. | Operating Environment |
| 3.2 | Support Software |
| 3.2.1 | Operating System |
| 3.2.2 | Compiler, Assembler |

The Program Maintenance Manual sections which apparently are not covered by 6.0/.20 are identified below. The caveats that were stated relative to 3560.1 also apply to this section.

| Section | Title | Contents |
|---|---|---|
| 2.1.2 | Input | Layout, medium, codes, units of measurement, format, range of values or reference to a data element dictionary. |
| 2.1.3 | Processing | Variables, constants, restrictions, switches, flags. |
| 2.1.4 | Output | Layout, medium. |
| 2.1.6 | Tables | Identification, content, location, structure, purpose. |
| 3.1 | Hardware | Equipment required for operation of system and for each program. |
| 3.3 | Data Base | Description of data bases used or reference to a data element dictionary (codes, units of measurement, format, range of values). |
| 4. | Maintenance Procedures | |
| 4.1 | Programming Conventions | Identification and descriptions. |
| 4.2 | Verification Procedures | Description of procedures to check the performance of programs, in general and following modification. Reference to test data and testing procedures. (6.0/.20 should reference the Trident Test Specification Requirements and Test Procedures which are described in Refs. 1 and 2). |
| 4.3 | Error Correction Procedures | Description of error conditions, sources and procedures for correction. (6.0/.20 should reference the Trident CCS Problem Reporting and Modification Systems which are described in Refs. 1 and 2.) |
| 4.4 | Special Maintenance Procedures | Description of special procedures which change with time or conditions (e.g., change of parameters, algorithms). |
| 4.5 | Listings and Flowcharts | Information about how to obtain copies of listings and flowcharts. |

NOTE: It is possible that Section 3.3 Data Base is not applicable to any of the programs documented by 6.0/.20.

C. With Respect to MIL-STD 1679 (Navy), Configuration Management, Pages 23-24

The following configuration management sections of 1679 are covered by 6.0/.20:

| Section | Title |
|---|---|
| 5.11 | Configuration Management |
| 5.11a | Positive identification of all program components |
| 5.11.1 | Configuration Identification |
| 5.11.1.1 | Baselines |
| 5.11.1.2 | Documentation Identification |
| 5.11.1.2a | Component |
| | b. Purpose |
| | c. Baseline |
| | d. Serial, edition and change status |

The sections which apparently are not covered by 6.0/.20 are identified below. The caveats that were stated relative to 3560.1 also apply to this section.

| Section | Title |
|---|---|
| 5.11b | Treatment of proposed changes to components under configuration control. |
| 5.11c | Implementation of approved changes and dissemination of corrected documentation and program changes. |
| 5.11d | Recording of status of all proposed changes. |
| 5.11e | Verification of change control, identification and status account of documentation and program materials. |

| | | |
|---|---|---|
| 5.11.2 | Configuration Control | Procedures for formal control of all documents, program materials and support library shall be established. |
| 5.11.2.1 | Software Changes | Proposed changes to software which is under configuration control shall be submitted to the appropriate software configuration control boards. |
| 5.11.2.2 | Documentation Changes | Procedures for controlling preparation and dissemination of changes to documentation shall be developed. |
| 5.11.2.3 | Software Configuration Control Boards | Each baseline plus approved changes from those baselines shall be under the formal control of a responsible board. |
| 5.11.3 | Configuration Status Accounting | Procedures to enable the generation of periodic status reports on all components under configuration management shall be established. |

With respect to the above sections, 6.0/.20 should reference the Trident CCS Problem Reporting and Modification Systems and the Configuration Management System which are described in Refs. 1 and 2.

## III. OTHER COMMENTS

The following comments pertain to 6.0/.20 Volume 2, using it as an example.

### A. Functional Description, on Pages 3-1 to 3-3

1. The discussion would be more meaningful if it were keyed to the hierarchical structure diagrams and to the flowcharts. For example, definitions and descriptions of pertinent interrupts should be provided, including important symbolic addresses which are utilized. This information and the interrupt numbers should be related to the diagrams.

2. Sub-headings for the various sections, such as "Interrupt Handling," would make the text more readable.

3. Some typos were observed which affect understandability. For example, the fifth line in the second paragraph on page 3-3.

4. Although this comment does not concern quality of documentation, it was noted on page 3-2 that the control memory test for all zeros and all ones should be preceded by setting the relevant portions of main memory to non-zero and non-one data, respectively, prior to the transfer of control memory to main memory.

### B. Hierarchical Structure Diagrams

1. Hierarchical structure diagrams and flowchart symbols should be defined at the beginning of each volume. It is not clear that these diagrams strictly adhere to ANSI standards (see Reference 3).

2. A consistent hierarchical structure box numbering system should be utilized which would indicate at a glance two important pieces of information: the function (e.g., "Periodic Entry") to which the routine belongs, and the level of the routine within the function. This scheme is shown on the accompanying hierarchical structure diagrams, which were reproduced from Volume 2 (pages 4-4 to 4-8). The left digit is function number, the middle digit is level number and the right digit is routine number for a given level and function. Level numbers start at "1" and increase from top to bottom; routine numbers start at "1" and increase from left to right. These numbers should be referenced to the pertinent flowcharts, as shown on the accompanying diagrams (pages 4-9 to 4-12 of Volume 2). As a means of tying together hierarchical structure diagrams, flowcharts and listings, the identification numbers could be appended to the listings as shown on the reproduced CMS-2 Assembler listing (page 6 of listing), which is attached. Two columns are utilized: one is the "At" column corresponding to lines with labels; the other is the "To" column corresponding to lines with transfer of control. Perhaps these identifiers could be punched and printed in formatted columns as part of the "Comments" field. A further help would be to sort source statements by the "At" column and to indent based on the middle digit. This would provided a structured listing of an entire function in contiguous locations.

3. Although it is not a fault of the flowcharting process, it was observed that there is a similarity of labels (e.g., CTPRE and CTPER). This could lead to error in software maintenance.

C. Flowcharts

1. The entry to a flowchart page should be annotated with the flowchart page numbers which are associated with the source(s) of the transfer of control and the exit(s) from a flowchart page should indicate the page number(s) which are associated with the destination(s) of the transfer of control. This is shown on the attached pages 4-9 to 4-12 of Volume 2.

2. There is no loop back to CTPER1 on page 4-9 of the flowcharts, as indicated by the JBNZ instruction at line 223 on page 6 of the listing. Instead the box at the bottom of page 4-9 reads: "Repeat Data Pattern Test Using 'IWC' Control Word." Similarly there is no loop back to CTPER2 on page 4-10 nor loop back to CTPER3 on page 4-11, as shown by line 230 and 238, respectively, on the listing. This method of presentation seems to mask an important characteristic of the program logic.

3. There seem to be discrepancies between flowcharts and listings. For example, the second box from the bottom of page 4-11 figure 4.3 refers to IWC. Page 6, lines 243 and 244 refer to ICW. The box in the flowchart also refers to "Set Up Class IV," while line 243 on the listing refers to Class II.

D. Interpretation of Hierarchical Structure Diagrams

1. Using Volume 2 as an example, it appears that the hierarchical structure diagrams are not totally accurate in portraying program logic. For example, the following discrepancies were noted between hierarchical structure and the listings:

a. With respect to page 4-5, figure 4.2, CTPER is shown superior to all other routines on this chart, yet an analysis of the listing reveals that CTPER only happens to be the first label in this series of code and its only paths to other labels are to CTPER1 and CTPERROR. The latter reference brings to light another discrepancy. CTPER does have a conditional branch to CTPERROR in the listing (line 219), but according to figure 4.2, there is no path between these routines. Wtih respect to figure 4.2, the listings indicate the following access paths among routines:

- CTPER accesses CTPER1 and CTPERROR.
- CTPER1 accesses CTPER2 and CTPERROR.
- CTPER2 accesses CTPER3 and CTPERROR.
- CTPER3 accesses CTRTN and CTPERROR.

Thus, a more accurate picture of this logic is shown in the diagram labeled "Revised Figure 4.2 CT Hierarchical Structure (2 of 5)." It should be noted that in this diagram the horizontal lines indicate paths between adjacent code segments that are in the same module and vertical lines indicate paths involving transfer of control. Also, the arrows, from left to right and from top to bottom, indicate the general direction of control flow. In large measure the "routines" which have been shown as hierarchical structures boxes in Volume 2 are simply labels in a segment of code. This has been pointed out in Volume 2 on page 4-3. The difficulty in constructing the hierarchical structure from program listings is that by definition, the diagrams are supposed to indicate hierarchy, i.e., superior-subordinate relationships, and programs designed using a top-down approach. Since the

programs were not written this way, the imposition of a hierarchical structure on a coding format that is inherently non-structured will lead to incompatibilities between diagrams and listings, unless great care is exercised in performing the translation.

b. Pages 4-7 and 4-8, figure 4.2, show CTKLAS2 as having access to CTKLASY. The listing indicates that this actually occurs via CTKLIPI (lines 314 and 342), which is not listed as a routine in figure 4.1, page 4-2 of volume 2. CTKLIPI also has a path to CTARITH via CTKL2XIT at line 349. Page 4-8 also shows no path between CTKAS2I and CTKLASY*. However, the listing shows this path to exist. This condition was verified by consulting the CMS-2 Assembler List Cross Reference Table. One of these references to CTKLASY occurs from the same routine.

- Pages 4-7 and 4-8 show no path between CTKLAS2 and CTKLAS2Z. However, line 335 on the listing shows that this label is contained within routine CTKLAS2.

- Page 4-8 shows no path between CTKLASY and CTKLAS2J. A check of the List Cross Reference Table revealed that this path does exist; this reference to CTKLAS2J occurs at line 430. However, this path is used only when a 4 stop condition does not exist.

- Taking the above difference into account, page 4-8 has been redrawn and is labeled as "Revised Figure 4.2 CT Hierarchical Structure (5 of 5)." Again, the procedure was to use horizontal arrows (going into side of box) to indicate adjacent code segment relationships (e.g., between CTKLAS2 and CTKLAS2Z and between CTKLAS2I and CTKLAS2J) and vertical arrows (going into top of box) to show transfer of control.

---

*At least it is not unambiguous as to whether there is a path between CTKLAS2 and CTKLASY or between CTKLAS2I adn CTKLASY, or both.

- Note: The revised hierarchical structure diagrams would obviously have different numbers for some boxes than those used in Section B.2. The latter was based on the given hierarchical structure diagrams as shown in Volume 2.

c. It was not clear in what sense lines with arrows and those without arrows were used in the hierarchical structure diagrams of Volume 2. If the use of arrows was to show transfer of control and the absence of arrows to tie together routines of the same module, the method would be inconsistent because there are no arrows on the lines which connect CTKLAS2 to CTKLAS2(A-I) in figure 4.2 of Volume 2.

E. Inter-Module Message Tables

These tables, such as the one on page 4-34, figure 4.4, Volume 2, should indicate the page number of the flowchart of the referenced procedure (routine).

F. Configurations

The hardware and configuration to which 6.0/.20 applies should be defined in each volume.

G. Patch Listings

Patch listings in Volume 1 should have column headings.

H. Audit Comments

Although we do not agree with the comment on page A-1, Volume 2 that, ". . . the module is readily understandable even though it is non-modular," we do feel that this is a valuable part of maintenance documentation. Perhaps this section could be expanded.

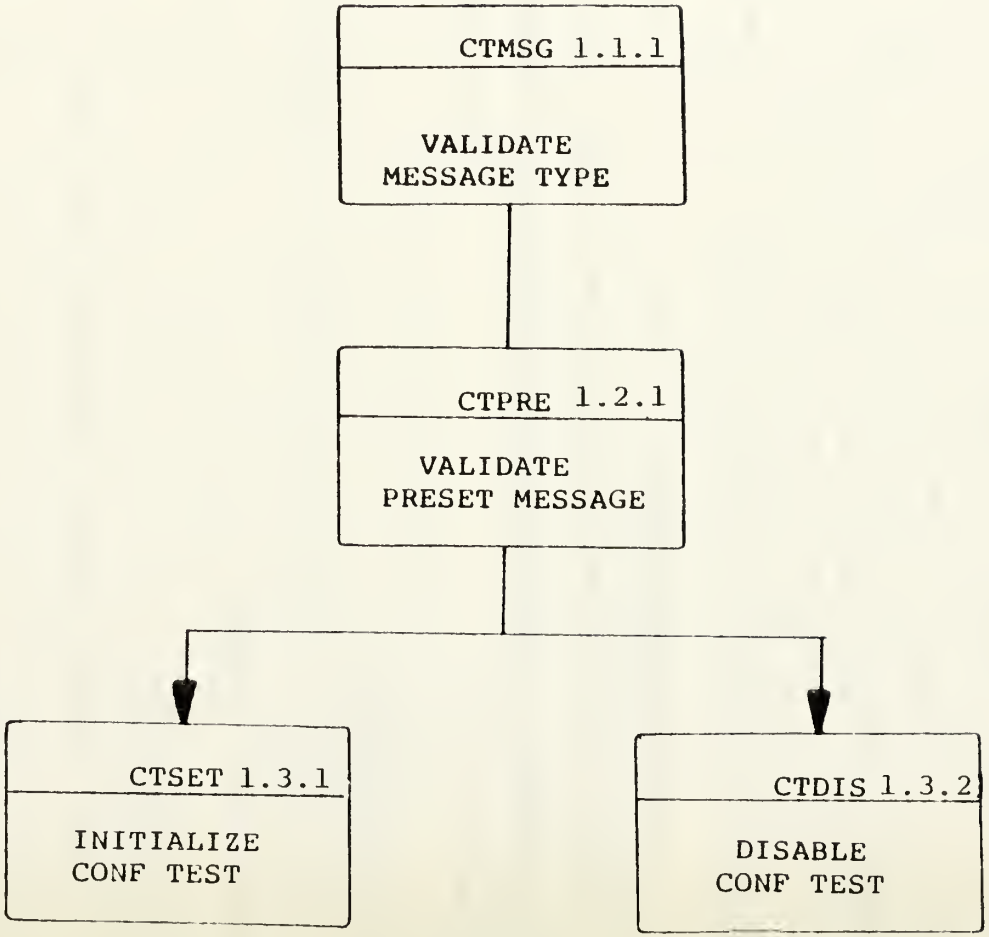


FIGURE 4.2 CT Hierarchical Structure (1 of 5)

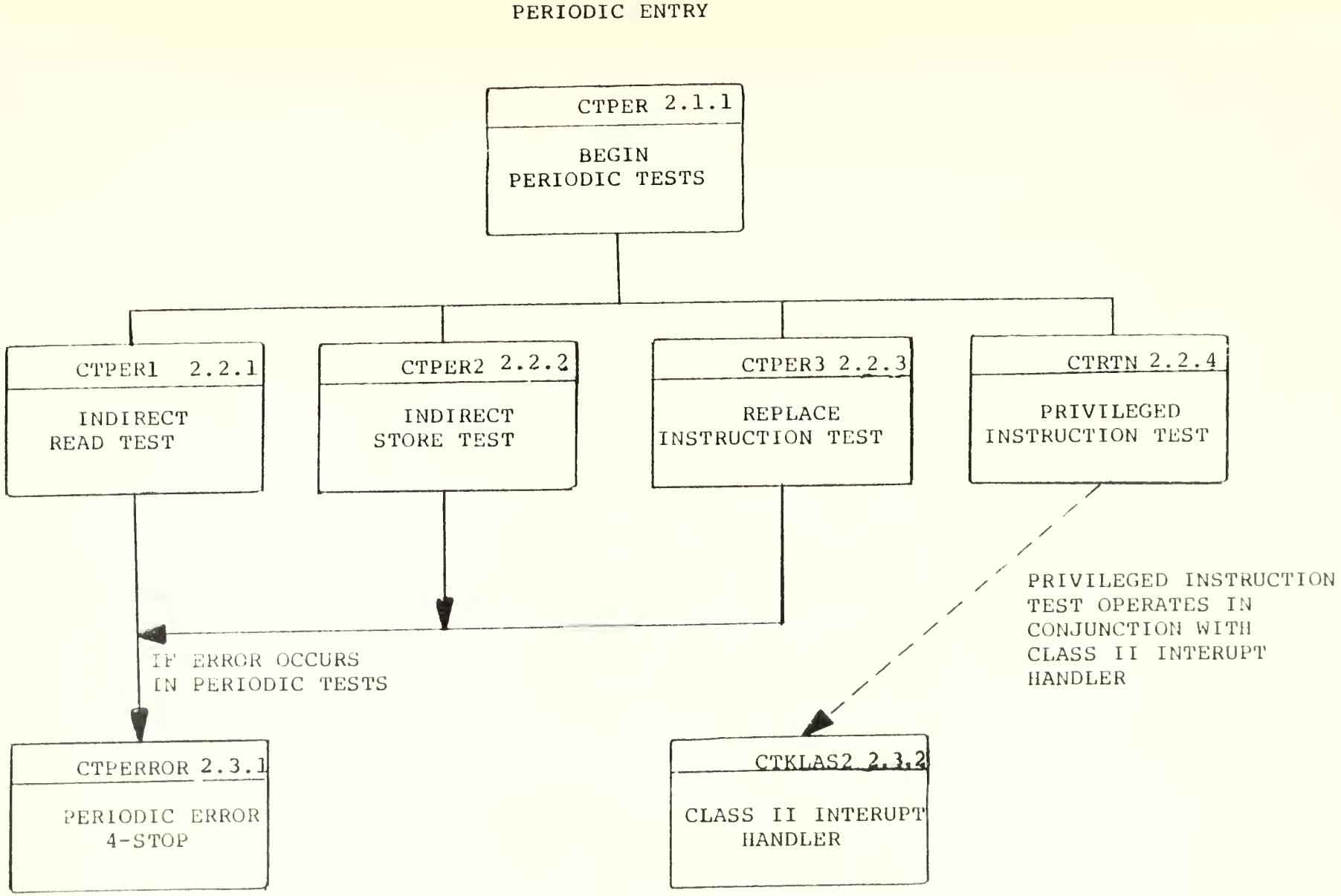


FIGURE 4.2 CT Hierarchical Structure (2 of 5)
Page 4-5

DEFERRED ENTRY

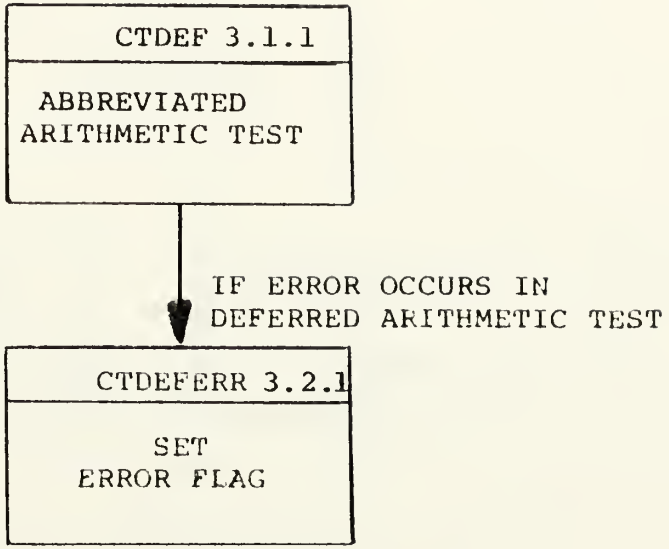




FIGURE 4.2 CT Hierarchical Structure (3 of 5)
Page 4-6

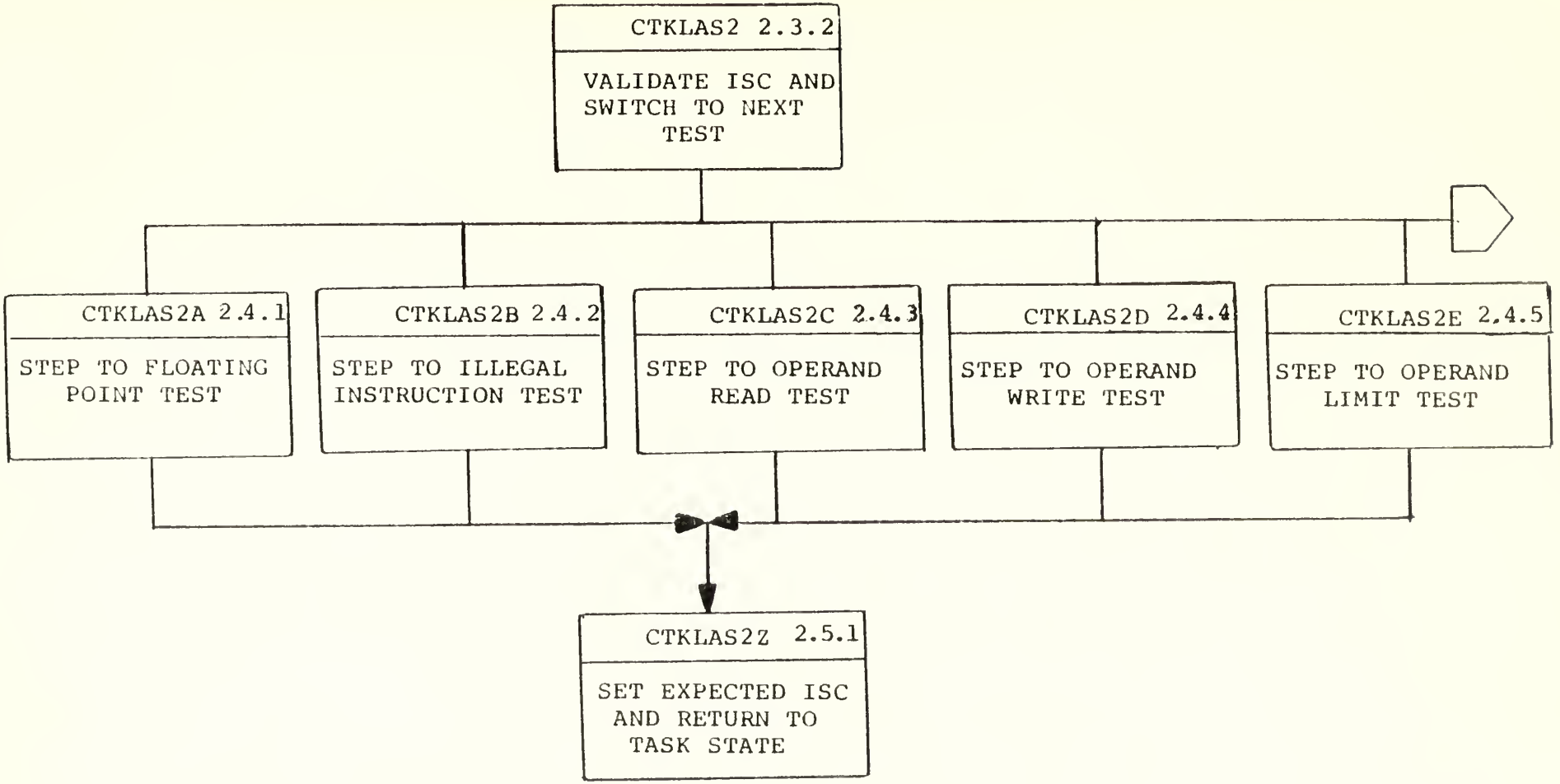


FIGURE 4.2 CT Hierarchical Structure (4 of 5)

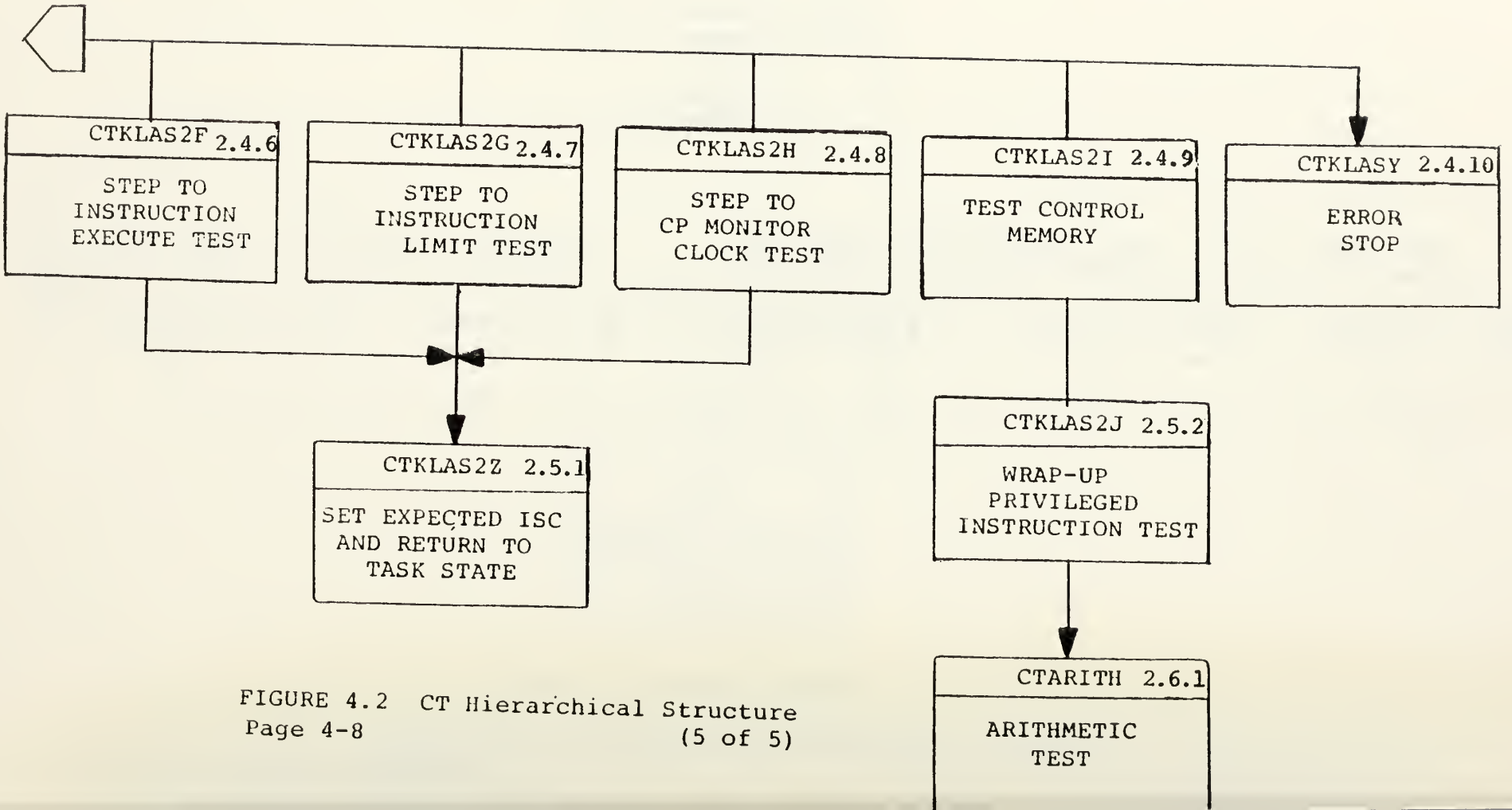


FIGURE 4.2 CT Hierarchical Structure (5 of 5)
Page 4-8

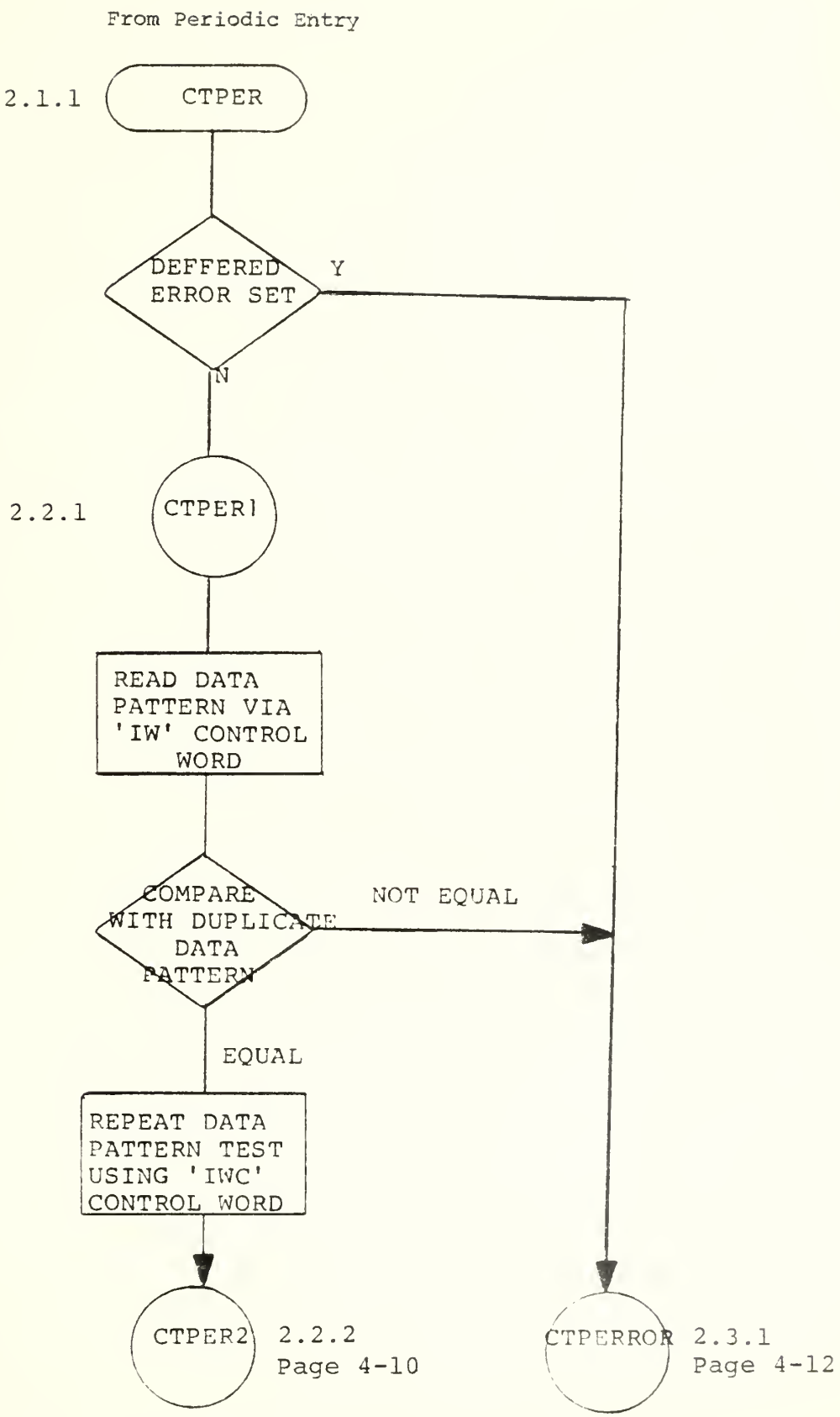


FIGURE 4.3 CT Flowcharts (1 of 25)
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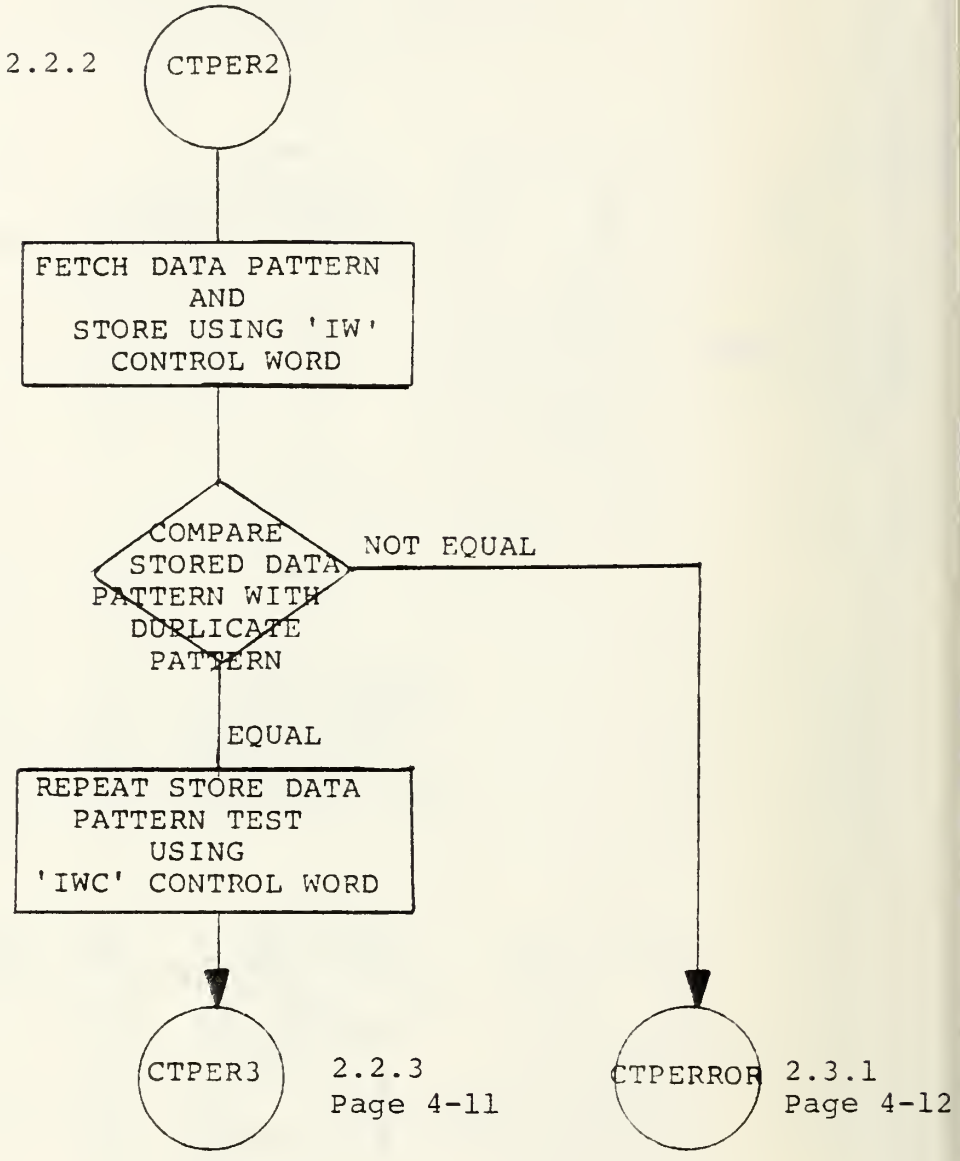
From Page 4-9




FIGUPE 4.3 CT Flowcharts (2 of 25)
Page 4-10

From Page 4-10

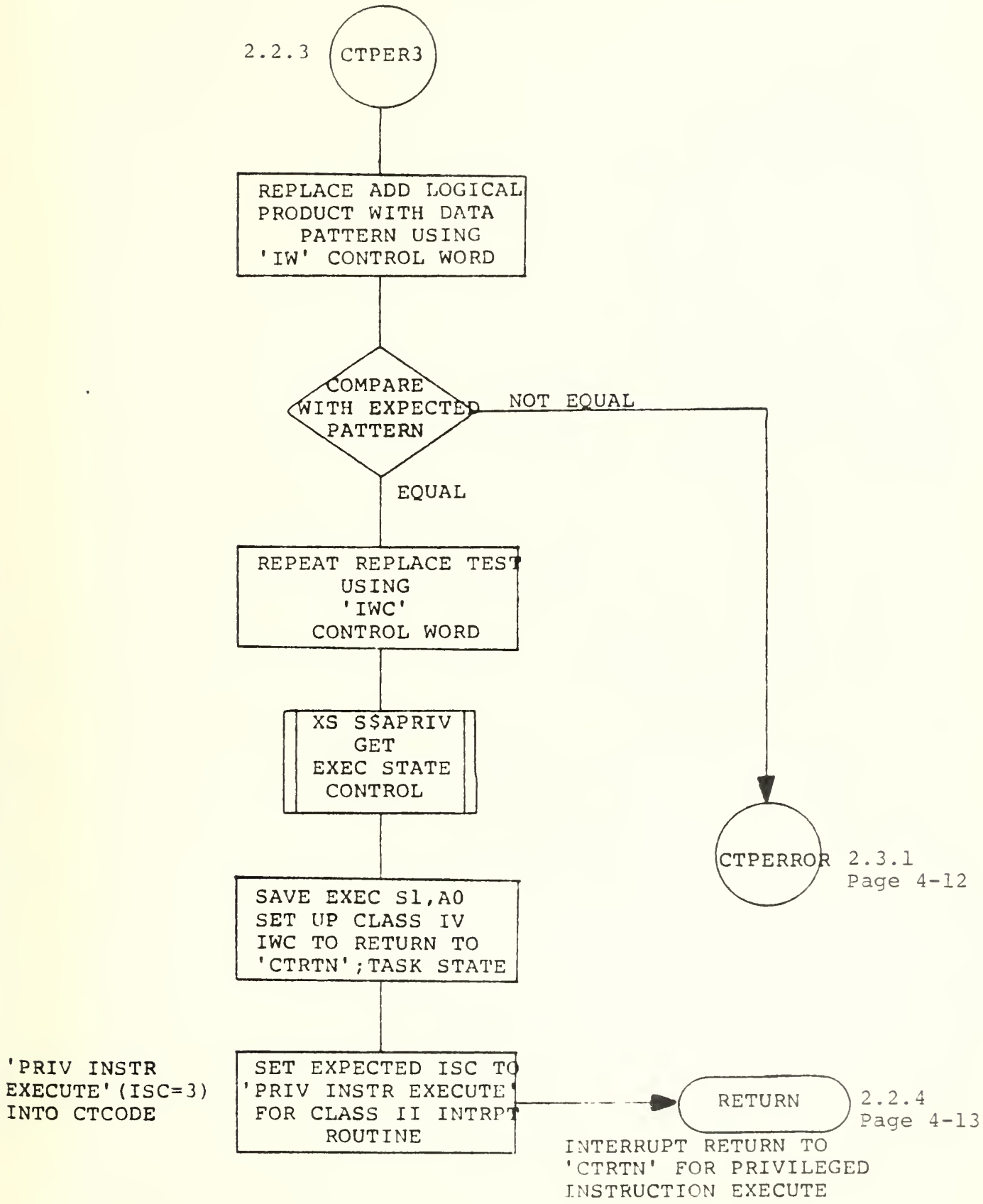



FIGURE 4.3 CT Flowcharts ( 3 of 25)
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From Pages 4-9,10,11

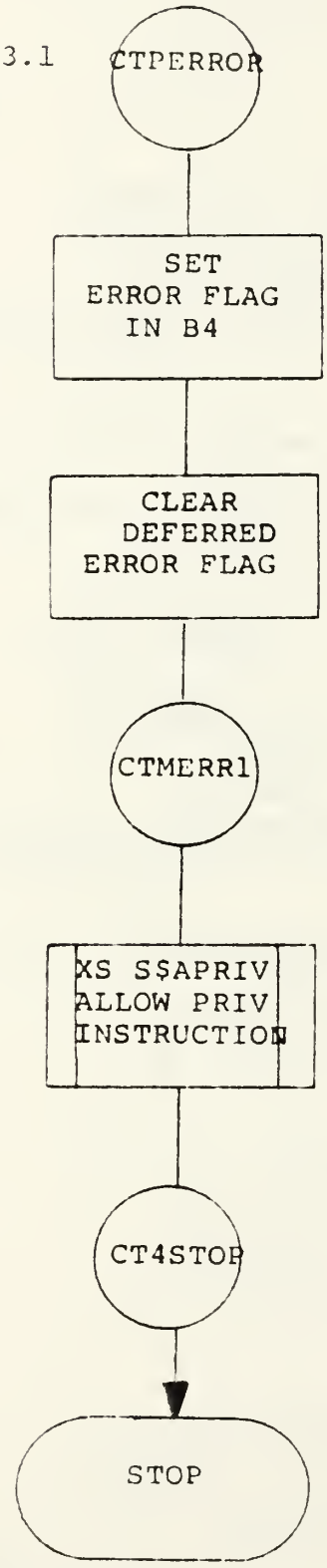


FIGURE 4.3 CT Flowcharts (4 of 25)
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Flow Chart I.D. A7 TO

```
 ID  S N AC  ADDR  F  A K B I  SY     LABEL    OP CODE    OPERAND                  COMMENTS                          SEQUENCE
 00191        000137 23 0 3 0 0 0 000521           SB         B0,CTERRFLAG,X3     . CLEAR ERROR FLAG                CTM1003/1
 00192        000140 07 0 0 0 0 0 000004           XS         S$EXIT              . EXIT                            CTM10038
 00193        000141 07 0 0 0 0 0 000104  CTDIS    XS         S$DELPER            . DELETE PERIODIC                 CTM10040
 00194        000142 07 0 0 0 0 0 000110           XS         S$DELDEF            . DELETE DEFERRED                 CTM10041
 00195        000143 10 0 0 0 0 0 0 00744          LA         A0,CTERM,GE,A0,B0,S0 .                                E1568Z
 00196        000144 10 1 0 0 0 0 000004           LA         A1,4                .                                 E1568Z
 00197        000145 07 0 0 0 0 0 000203           XS         S$DMES              .                                 E1568Z
 00198        000146 07 0 0 0 0 0 000004           XS         S$EXIT              . EXIT                            CTM10042
 00199        000147 20 4 0 0 0 0 000100  CTHERR    LB         B4,0                . MESSAGE ENTRY FLAG              CTM10087
 00200        000150 07 0 0 0 0 0 000425  CTHERR1   XS         S$APRIV             . ENABLE PRIVELEGED INST.         CTM10091
 00201        000151 53 4 3 0 0 0 0 000051 CT4STOP   JSC        4,CT4STOP           . 4 STOP                          CTM10092
 00202                                    . ********** PERIODIC ENTRY                                  **********   CTM10104
 00203        000152 20 7 0 0 0 0 000001  CTPER     LB         B7,1                . INDIRECT ADDRESSING TEST        CTM10105  2.1.1
 00217                                               END$ I     BRCONDE, CTERRLU    . C-SWITCH END FIXED S U
 00218        000153 42 02 0 0 0 000521            AC         2,CTERFLAG          . CHECK DEFERRED ERROR            CTM10105A
→00219        000154 53 0 1 0 0 0 000337           JNE        CTPERROR            . GO TO ERROR MESSAGE             CTM10106A  2.3.1
→00220        000155 10 0 3 7 1 000475  CTPER1    LA         A0,•CTRDIR1,X3,B7   . CHECK READ CLASS              CTM10106   2.2.1
 00221        000156 44 0 3 7 0 000477             C          A0,CTC1,X3,B7       . IS IT CORRECT                   CTM10107
 00222        000157 53 0 1 0 0 0 000337           JNE        CTPERROR            . IF NOT GO TO ERROR              CTM10108   2.3.1
→00223        000160 52 7 1 0 0 0 000055           JBNZ       B7,CTPER1           . TEST BOTH IN AND INC            CTM10109   2.2.1
 00224        000161 20 7 0 0 0 0 000001           LB         B7,1                . CHECK STORE CLASS               CTM10110
 00225        000162 10 0 3 7 0 000473  CTPER2    LA         A0,CT2SPAT,X3,B7    .                                 CTM10111  2.2.2
 00226        000163 24 0 3 7 1 000503             SA         A0,•CTIDRV1,X3,B7   . TRY IT                          CTM10112
 00227        000164 10 0 3 7 0 000505             LA         A0,CTV1,X3,B7       . FETCH WHOLE WORD                CTM10113
 00228        000165 44 0 3 7 0 000501           C            A0,CTC2,X3,B7       . CHECK IT                        CTM10114
 00229        000166 53 0 1 0 0 0 000337           JNE        CTPERROR            . IS IT CORRECT                   CTM10115   2.3.1
→00230        000167 52 7 1 0 0 0 000062           JBNZ       B7,CTPER2           . GET BOTH                        CTM10116   2.2.2
 00231        000170 71 7 2 7 6                    BAN        A7,A7               . CLEAR MASK                      CTM10117
 00232        000171 20 7 0 0 0 000001             LB         B7,1                . TEST REPLACE CLASS              CTM10118
 00233        000172 10 0 3 7 0 000473  CTPER3    LA         A0,CT2SPAT,X3,B7    .                                 CTM10119  2.2.3
 00234        000173 03 7 4 7 1 000503             XALP       A7,•CTIDRV1,B7      . TRY IT                          CTM10120
 00235        000174 10 0 3 7 0 000505             LA         A0,CTV1,X3,B7       . CHECK IT                        CTM10121
 00236        000175 44 0 3 7 0 000501             C          A0,CTC2,X3,B7       .                                 CTM10122
 00237        000176 53 0 1 0 0 0 000337           JNE        CTPERROR            . IS IT CORRECT                   CTM10123   2.3.1
→00238        000177 52 7 1 0 0 0 000072           JBNZ       B7,CTPER3           . TRY BOTH                        CTM10124   2.2.3
 00239                                    . **** PRIVILEGED INSTRUCTION TEST                                     CTM10125
 00240        000200 07 0 0 0 0 0 000425           XS         S$APRIV             . GET EXEC STATE CONTROL          CTM10126
 00241        000201 54 70 0 0 0 000510            LCI        070,CTASR1          . SET ALL INTERRUPT LOCKOUTS      CTM10127
 00242        000202 57 00 0 0 0 000514            SCI        0,CTINTEM3          . SAVE EXEC A0                    CTM10128
→00243        000203 57 44 0 0 0 000512            SCI        044,CTINTEM1        . SAVE CLASS II IOW               CTM10129
→00244        000204 55 44 0 0 0 000516            LCI        044,CTINTEN1        . SET UP IOW                      CTM10130
 00245        000205 57 21 0 0 0 000513            SCI        021,CTINTEM2        . SAVE EXEC S1                    CTM10131
 00246        000206 60 21 0 0                     HSCT       021,A0              . SET UP EXEC S1                  CTM10132
 00247        000207 61 21 0 1                     HSCI       021,A0              .                                 CTM10133
 00248        000210 55 55 0 0 0 000511            LCI        055,CTASR2          . PREPARE TO GO TO TASK           CTM10134
 00249        000211 55 57 0 0 0 000515            LCI        057,CTPSTA          .                                 CTM10135
 00250        000212 23 0 3 0 0 0 000524           SB         B0,CTCOUNT1,X3      . CLEAR INTERRUPT COUNTER         CTM10136
 00251        000213 10 0 0 0 0 0 000003           LA         A0,3                .                                 CTM10137
 00252        000214 24 0 3 0 0 0 000525           SA         A0,CTCODE,X3        .                                 CTM10138
 00253        000215 07 0 5 0 0 0 0 00001          IR                             . TO TASK STATE                   CTM10139
 00254        000216 07 0 2 0 0 0 000000  CTRIP    PEI        0                   . EXECUTE PRIVILEGED INSTRUCT     CTM10140   2.2.4
 00255        000217 07 0 3 0 0 0 000000           EIR        0                   .                                 CTM10141
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ID  FOR AC  ADDR  F  A K B I   SY      LABEL   OP CODE   OPERAND          COMMENTS                    SEQUENCE
00256        000117 07 0 4 0 0 000000          IO        0                .                           CTM10142
00257        000120 07 0 5 0 0 0 00000         IR        0                .                           CTM10143
00258        000121 53 4 2 0 0 0 000000        RJSC      4                .                           CTM10144
00259        000122 53 4 3 0 0 0 000000        JSC       4                .                           CTM10145
00260        000123 54 20 0 0 000000           LCT       020              .                           CTM10146
00261        000124 54 60 0 0 000000           LCT       060              .                           CTM10147
00262        000125 54 70 0 0 000000           LCT       070              .                           CTM10148
00263        000126 55 00 0 0 000000           LCI       0                .                           CTM10149
00264        000127 56 20 0 0 000000           SCT       020              .                           CTM10150
00265        000130 56 60 0 0 000000           SCT       060              .                           CTM10151
00266        000131 56 70 0 0 000000           SCT       070              .                           CTM10152
00267        000132 60 20 0 0                  HSCT      020              .                           CTM10154
00268        000132 74 0 3 0 0                 HNO                        .                           CTM10153
00269        000133 60 60 0 0                  HSCT      060              .                           CTM10156
00270        000133 74 0 3 0 0                 HNO                        .                           CTM10155
00271        000134 60 70 0 0                  HSCT      070              .                           CTM10158
00272        000134 74 0 3 0 0                 HNO                        .                           CTM10157
00273        000135 60 00 0 1                  HSCI      A0               .                           CTM10160
00274        000135 74 0 3 0 0                 HNO                        .                           CTM10159
00275        000136 61 20 0 0                  HLCT      020              .                           CTM10162
00276        000136 74 0 3 0 0                 HNO                        .                           CTM10161
00277        000137 61 60 0 0                  HLCT      060              .                           CTM10164
00278        000137 74 0 3 0 0                 HNO                        .                           CTM10163
00279        000140 61 70 0 0                  HLCT      070              .                           CTM10166
00280        000140 74 0 3 0 0                 HNO                        .                           CTM10165
00281        000141 61 00 0 1                  HLCI      A0               .                           CTM10168
00282        000141 74 0 3 0 0                 HNO                        .                           CTM10167
00283        000142 77 0 0 0 0                 HSIM      0                .                           CTM10170
00284        000142 74 0 3 0 0                 HNO                        .                           CTM10169
00285        000143 77 0 4 0 0                 HPI                        .                           CTM10172
00286        000143 74 0 3 0 0                 HNO                        .                           CTM10171
00287        000144 77 0 5 0 0                 HAI                        .                           CTM10174
00288        000144 74 0 3 0 0                 HNO                        .                           CTM10173
00289        000145 77 0 6 0 0                 HALT                       .                           CTM10176
00290        000145 74 0 3 0 0                 HNO                        .                           CTM10175
00291        000146 77 0 6 0 1                 HWFI                       .                           CTM10178
00292        000146 74 0 3 0 0                 HNO                        .                           CTM10177
00293        000147 07 1 0 0 0 000000          IPI       0                .                           CTM10179
00294        000150 07 0 1 0 0 000000          AEI       0                .                           CTM10180
00295        000151 05 0 0 0 0 000517          DL        A0,CTONES        . GENERATE FLOATING         CTM10181
00296        000152 06 0 0 0 0 000517          FA        A0,CTONES        . POINT ERROR               CTM10182
00297        000153 00000000000                +         0                . GENERATE ILLEGAL INSTRUCTION CTM10183
00298        000154 10 0 3 0 0 4 00154  CTOP1  LA        A0,CTOP1,K3,,SCTTRAN4      . OPERAND READ ERR   CTM10184
00299        000155 24 0 3 0 0 0 00155  CTOP2  SA        A0,CTOP2,K3,,SCTTRAN0      . OPERAND WRITE ERR  CTM10185
00300        000156 24 0 3 0 0 5 00156  CTOP3  SA        A0,CTOP3,K3,,SCTTRAN5      . OPERAND LIMIT ERR  CTM10186
00301        000157 53 0 3 0 0 0 6 00160       J         S+1, , ,SCTTRAN6           .                    CTM10187
00302        000160 20 0 0 0 0 000000  CTOP4  LB        B0,0                       . INSTRUCTION EXECUTE CTM10188
00303        000161 53 0 3 0 0 0 5 00162       J         S+1, , ,SCTTRAN5           .                    CTM10189
00304        000162 20 0 0 0 0 000000  CTOP5  LB        B0,0                       . INSTRUCTION LIMIT  CTM10190
00305        000163 53 0 3 0 0 0 000163 CTOP6  J         CTOP6            . WAIT FOR INTERRUPT        CTM10192
00306                                  . *** INTERRUPT  ...TIME FOR CLASS 2 ERRORS                   CTM10193
00307        000164 54 70 0 0 000510   CTKEAS2 LCI       070,CTASR1       . TO TASK REGISTERS         CTM10194
```

```
 LOC  MEM AC  ADDR  F  A K E I   ST     LABEL    OP CODE   OPERAND                  COMMENTS                          SEQUENCE
 00309        000165 20 46 0 1                     HSCI      046,AO                   , CHECK STATUS CODE               CTM10195
 00309        000166 20 0 0 0 0 000000             LB        B0,0                     ,                                 CTM10196
 00310        000167 35 1 3 0 0 000524             RI        A1,CTCOUNT1,R3           , INCREMENT TEST COUNT            CTM10197
 00311        000170 44 0 3 0 0 000525             C         A0,CTCODE,R3             , IS STATUS CODE CORRECT          CTM10198
 00312                                             .
 00313                                             . PPPP
```

```
ID  F R IC  ADDR  F  A K B I  SY     LABEL     OP CODE   OPERAND          COMMENTS                    SEQUENCE
00360       000237 10 0 0 0 0 000012  CTKLAS2E  LA        A0,012           , OPERAND LIMIT             CTM10231
00361       000240 53 0 3 0 0 0 000214          J         CTKLAS2Z         ,                           CTM10232
00362       000241 10 0 0 0 0 0 000015  CTKLAS2F  LA        A0,015           , INSTRUCTION EXECUTE       CTM10233
00363       000242 53 0 3 0 0 0 000214          J         CTKLAS2Z         ,                           CTM10234
00364       000243 55 47 0 0 0 000522   CTKLAS2G  LCI       047,CTDUMPR1     , RESTORE S1 TO P-STORE     CTM10235
00365       000244 10 0 0 0 0 0 000016          LA        A0,016           , INSTRUCTION LIMIT         CTM10236
00366       000245 53 0 3 0 0 0 000214          J         CTKLAS2Z         ,                           CTM10237
00367       000246 55 47 0 0 0 000523   CTKLAS2H  LCI       047,CTDUMPR2     , RESTORE S1 TO P-STORE     CTM10238
00368       000247 10 0 0 0 0 0 000017          LA        A0,017           , CP MONITOR CLOCK          CTM10239
00369       000250 55 10 0 0 0 000526           LCI       010,CTCLK        , LOAD CP MONITOR CLOCK     CTM10191
00370       000251 53 0 3 0 0 0 000214          J         CTKLAS2Z         ,                           CTM10240
00371       000252 20 7 0 0 0 0 000100  CTKLAS2I  LB        B7,0100          , SAVE EXEC REGISTERS       CTM10241
00372       000253 20 1 0 0 0 0 000300          LB        B1,0             ,                           CTM10241C
00373       000254 23 0 3 0 0 0 000521          SB        B0,CTERFLAG,K3   , CLEAR FLAG                CTM10241D
00374       000255 07 7 6 0 0 0 000001          RP        7,1              ,                           CTM10242
00375       000256 57 00 1 0 0 000531           SCI       A0,CTREGSTR,B1   ,                           CTM10243
00376       000257 20 7 0 0 0 0 000010          LB        B7,010           , LOAD WITH ZEROES ES2I     CTM10244
00377       000260 07 7 6 0 0 0 000000          RP        7                ,                           CTM10245
00378       000261 55 00 0 0 0 000527           LCI       A0,CTOHPAT       ,                           CTM10246
00379       000262 20 7 0 0 0 0 000067          LB        B7,0A7           .                           **ES2I**
00380       000263 07 7 6 0 0 0 000000          RP        7                .                           **ES2I**
00381       000264 55 11 0 0 0 000527           LCI       011,CTOHPAT      .                           **ES2I**
00382       000265 20 7 0 0 0 0 000100          LB        B7,0100          , STORE AWAY                CTM10247
00383       000266 20 1 0 0 0 0 000000          LB        B1,0             ,                           CTM10247I
00384       000267 07 7 6 0 0 0 000001          RP        7,1              ,                           CTM10248
00385       000270 57 00 1 0 0 000631           SCI       A0,CTEMPSTR,B1   ,                           CTM10249
00386       000271 20 7 0 0 0 0 000100          LB        B7,0100          , CHECK THEM                CTM10250
00387       000272 23 0 3 0 0 0 000641          SB        B0,CTEMPSTR+010,K3 .                         **ES2I**
00388       000273 20 1 0 0 0 0 000000          LB        B1,0             ,                           CTM10250I
00389       000274 07 0 6 0 0 0 000001          RP        0,1              ,                           CTM10251
00390       000275 10 0 3 1 0 000631            LA        A0,CTEMPSTR,K3,B1  ,                         CTM10252
→00391      000276 52 7 1 0 0 0 000335          JBNZ      B7,CTKLASY       , GO IF ERROR               CTM10253
00392       000277 20 7 0 0 0 0 000100          LB        B7,0100          , CHECK WITH ONES           CTM10254
00393       000300 07 7 6 0 0 0 000000          RP        7                ,                           CTM10255
00394       000301 55 00 0 0 0 000517           LCI       A0,CTONES        ,                           CTM10256
00395       000302 20 7 0 0 0 0 000100          LB        B7,0100          , TO TEMPORARY STORAGE      CTM10257
00396       000303 20 1 0 0 0 0 000000          LB        B1,0             ,                           CTM10257I
00397       000304 07 7 6 0 0 0 000001          RP        7,1              ,                           CTM10258
00398       000305 57 00 1 0 0 000631           SCI       A0,CTEMPSTR,B1   ,                           CTM10259
00399       000306 20 7 0 0 0 0 000100          LB        B7,0100          , CHECK THEM                CTM10260
00400       000307 20 1 0 0 0 0 000000          LB        B1,0             ,                           CTM10260I
00401       000310 07 7 6 0 0 0 000001          RP        7,1              ,                           CTM10261
00402       000311 14 0 3 1 0 000631            AA        A0,CTEMPSTR,K3,B1  ,                         CTM10262
00403       000312 13 0 3 0 0 000530            ANA       A0,CTCONST1,K3   ,                           CTM10263
→00404      000313 51 0 3 0 0 0 000335          JNZ       A0,CTKLASY       ,                           CTM10264
00405       000314 20 1 0 0 0 0 000000  CTKLAS2J  LB        B1,0             , RESTORE ORIGINAL CONTENTS CTM10265
00406       000315 20 7 0 0 0 0 000100          LB        B7,0100          ,                           CTM10266
00407       000316 07 7 6 0 0 0 000001          RP        7,1              ,                           CTM10267
00408       000317 55 00 1 0 0 000531           LCI       A0,CTREGSTR,B1   ,                           CTM10268
00409                                 , ***PERIODIC TEST PASSED            ,                           CTM10269
00410                                 .                                    .
00411                                 . PPPP
```

```
ID  E F AC  ADDR  F  A K B I   SY     LABEL   OP CODE   OPERAND                COMMENTS                  SEQUENCE

00412                                CTKL2XIT,                                                          P
00413                                , PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
00414                                , *
00415      000320 55 00 0 0 000514          LCI       A0,CTINTEM3          , RESTORE EXEC REGISTERS      CTM10270
00416      000321 55 44 0 0 000512          LCI       044,CTINTEM1         ,                             CTM10271
00417      000322 55 21 0 0 000513          LCI       021,CTINTEM2         ,                             CTM10272
00418      000323 55 45 0 0 000517          LCI   045,CTASR                ; ASR = 0                     CTM102721
00419      000324 42 00 0 0 000521          BC    0,CTERFLAG               , SEND ERROR MESSAGE          CTM102722
00420      000325 53 1 1 0 0 0 000327       JE    CTXITO                   , NO-JUMP                     CTM102723
00421      000326 55 45 0 0 000510          LCI   045,CTASR1               , ASR MAINTAIN LOCKOUT        CTM102724
00422                                CTXITO   .         COMPLETE STATE SWITCH                           CTM102725
00423      000327 55 47 0 0 000731          LCI       047,CTPSTR4          , STALL                       CTM10274
00424      000330 07 0 5 0 0 0 00000        IR                             , GO TO TASK                  CTM10275
00425      000331 42 00 0 0 000521  CTXIT    BC        0,CTERFLAG           , NEED ERROR MESSAGE          CTM10276
00426      000332 53 0 1 0 0 0 000337       JNL       CTPERROR             ;                             CTM10277
00427      000333 52 1 0 0 0 0 000415       LBJ       B1,CTARITH           ,                             ''E15082''
00428      000334 07 0 0 0 0 000004  CTXIT1   XS        S$EXIT               , EXIT                        CTM10278
00429      000335 53 4 3 0 0 0 000051 CTKLASY JSC       4,CT4STOP            , 4 STOP ON ERROR DETECTION   CTM10279
00430      000336 53 0 3 0 0 0 000314       J         CTKLAS21             , FINISH RESTORING REGISTERS  CTM10280
00431      000337 20 4 0 0 0 000005  CTPERROR LQ        04,5                 , SET FLAG                    CTM10281
00432      000340 32 02 0 0 000521          BZ        2,CTERFLAG           , CLEAR DEFERRED ERROR        CTM102811
00433      000341 53 0 3 0 0 0 000050       J         CTMERR1              , PICK ERROR MESSAGE          CTM102812
00434      000342 00000002000       CTDEFSTR +02000                        , 1 SEC. BETWEEN SLICES       CTM102821
00435      000343 00000024000               +024000                        , 10 SEC. BETWEEN JOBS        CTM102822
00436      000344                           RES + 34                       , DEFERRED SAVE AREA          CTM102823
00437      000400 05 0 0 0 0 000473  CTDEF    DL        A0,CT2SPAT           ,                             CTM10303
00438      000401 71 2 2 2 0                HAN       A2,A2                ,                             CTM10304
00439      000401 64 3 0 40                 HRZ       A3,32                ,                             CTM10305
00440      000402 71 2 1 0 0                HA        A2,A0                ,                             CTM10306
00441      000402 71 3 2 1 0                HAN       A3,A1                ,                             CTM10307
00442      000403 70 3 2 0 0                HCP       A3                   ,                             CTM10308
00443      000403 61 04 0 0                 HLCT      A4,A0                ,                             CTM10309
00444      000404 61 05 1 0                 HLCT      A5,A1                ,                             CTM10310
00445      000404 74 0 4 2 0                HC        A0,A2                ,                             CTM10311
00446      000405 53 0 1 0 0 0 000413       JNE       CTDEFERR             ,                             CTM10312
00447      000406 74 3 4 5 0                HC        A3,A5                ,                             CTM10313
00448      000407 53 0 1 0 0 0 000413       JNE       CTDEFERR             ,                             CTM10314
00449      000410 71 2 2 4 0                HAN       A2,A4                ,                             CTM10315
00450      000410 71 3 2 5 0                HAN       A3,A5                ,                             CTM10316
00451      000411 56 2 3 0 0 0 000413       DJNZ      A2,CTDEFERR          ,                             CTM10317
00452      000412 07 0 0 0 0 000004         XS        S$EXIT               ,                             CTM10320
00453      000413 33 01 0 0 000521  CTDEFERR DS        01,CTERFLAG          , SET ERROR FLAG              CTM10321
00454      000414 07 5 0 0 0 000004         XS        S$EXIT               ,                             CTM10322
00455                                CTARITH  , QUIT    ARITHMETIC TEST      ,                             ''E15082''
00456      000415 05 0 0 0 0 000473         DL        A0,CT2SPAT           ,                             ''E15082''
00457      000416 05 2 0 0 0 000473         DL        A2,CT2SPAT           ,                             ''E15082''
00458      000417 05 4 0 0 0 000473         DL        A4,CT2SPAT           ,                             ''E15082''
00459      000420 05 6 0 0 0 000473         DL        A6,CT2SPAT           ,                             ''E15082''
00460      000421 63 0 0 40                 HDEC      A0,32                ,                             ''E15082''
00461      000421 74 0 4 7 0                HC        A0,A7                ,                             ''E15082''
00462      000422 53 0 1 0 0 0 000427       JNL       CTMERR2              ,                             ''E15082''
00463      000423 63 2 0 41                 HDEC      A2,33                ,                             ''E15082''
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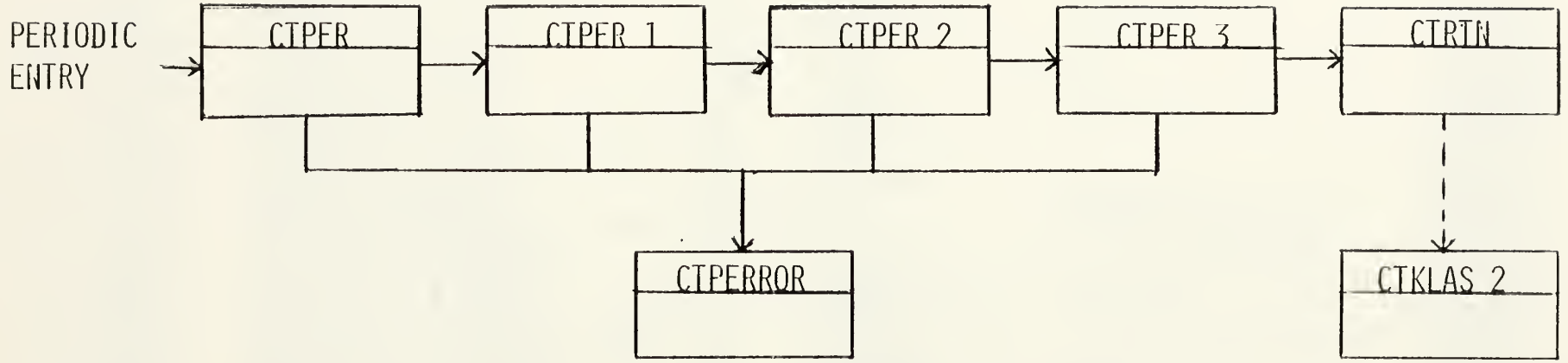
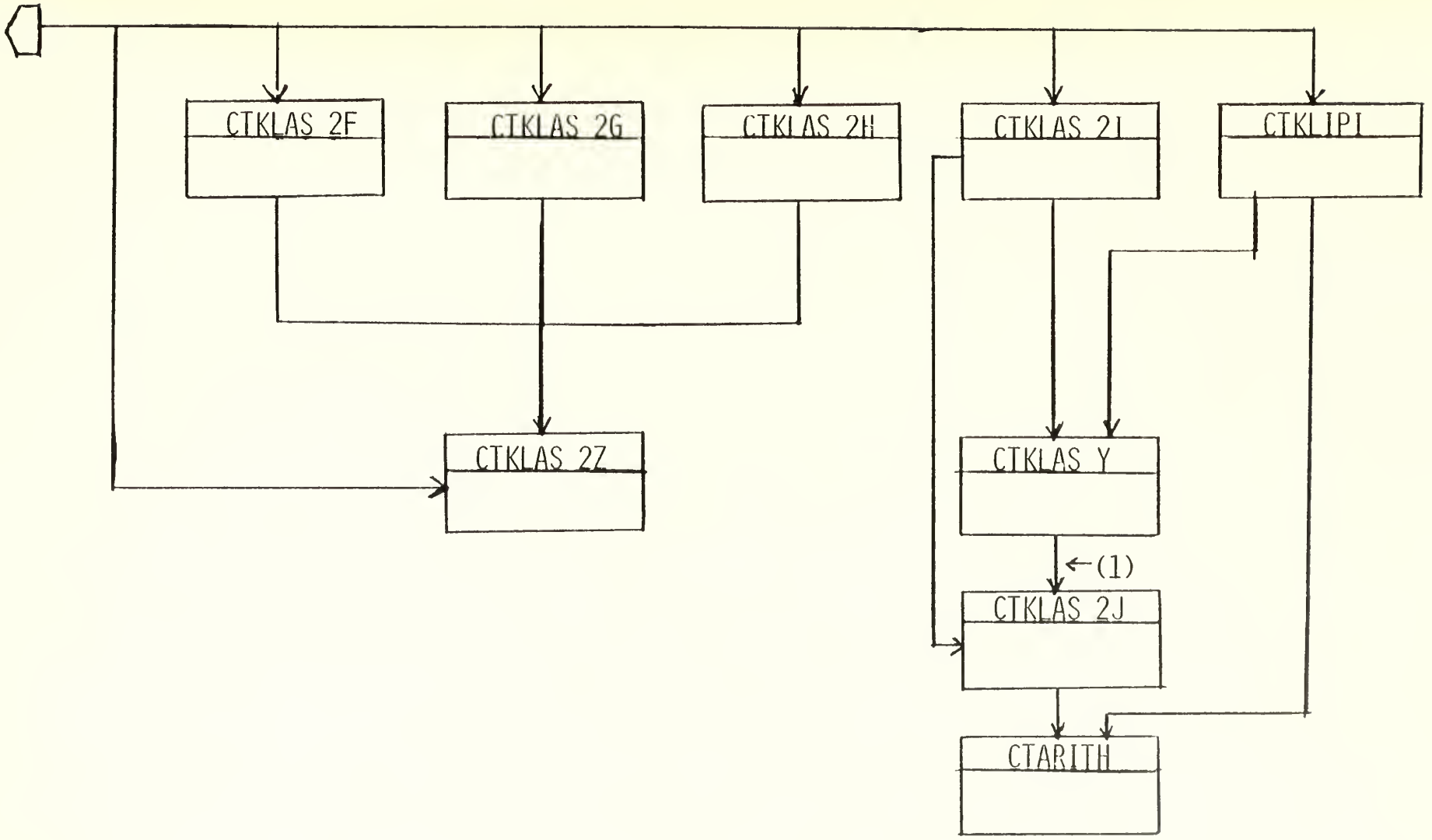



REVISED FIGURE 4.2 CT HIERARCHICAL STRUCTURE (2 OF 5)
REVISED Page 4-5




(1) USED ONLY WHEN A 4 STOP CONDITION DOES NOT EXIST.

REVISED FIGURE 4.2 CT HIERARCHICAL STRUCTURE (5 OF 5)

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## REFERENCES


1. Oxman, Steven W., "Fiscal Year 1979 CCSMA System-Level Software Maintenance Approach and Transition Plan," March 20, 1979, (Revision E), Software Systems Department, Trident, CCSMA, New port, RI.

2. Oxman, Steven W., "The Testing of the Trident Command and Control System," Workshop on Software Testing and Test Documentation, December 1978, Digest.

3. Chapin, Ned, "Flowcharting with the ANSI Standard: A Tutorial," Computing Surveys, ACM, June 1970, Volume 2, No. 2.

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